



FLORIDA SOLAR ENERGY CENTER

Creating Energy Independence Since 1975

The Future for Power from Photovoltaic Systems

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Florida Solar Energy Center

2006 International Workshop on Pollution
Prevention and Sustainable Development

A Research Institute of the University of Central Florida





What is the Florida Solar Energy Center?





Florida Solar Energy Center



- ◆ Created in 1975 by the Florida Legislature
- ◆ **The** energy research institute of the state of Florida
- ◆ Mission is research, testing and education
- ◆ More than \$9 - 12 million annually in external contracts and grants
- ◆ The experience, staff (>140) and capabilities to help solve our energy problems and help meet our energy needs
- ◆ Began as a “solar energy” center, but grew into many new research and development areas
- ◆ Housed in one of the world’s most energy-efficient buildings.



FSEC Program Areas



- ◆ **High-Performance Buildings** (energy efficiency)
- ◆ **Solar Thermal Systems** (today's cost-effective solution)
- ◆ **Photovoltaics** (solar electricity)
- ◆ **Testing & Certification** (protecting Florida's citizens)
- ◆ **Hydrogen and Fuel Cells** (the future's fuels and engines)
- ◆ **Education and Training** (Florida's workforce for today and the future)
- ◆ **Alternative Fuels & Transportation** (an agricultural opportunity for Florida)

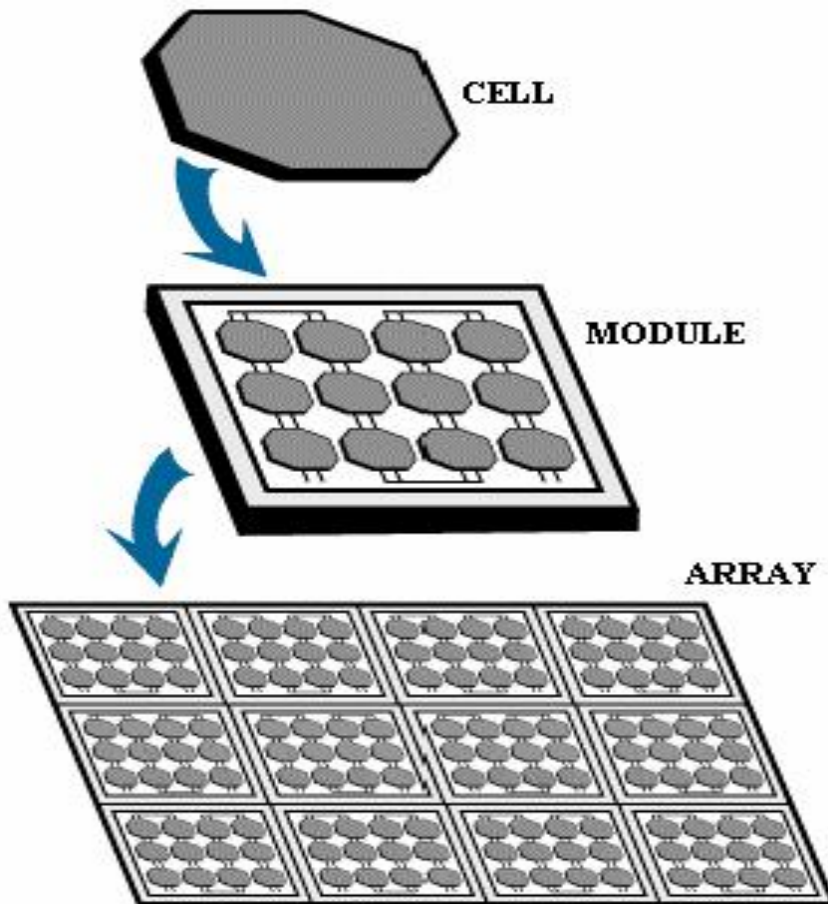
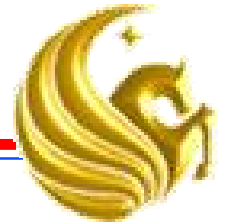


What is PV?





Photovoltaics



1839 Edmund Bequerel

1905 Albert Einstein

1954 Bell Laboratories

1960s the space industry



Solar Applications





◆ PV Numbers

- $1\text{kWp} \cong 100\text{ ft}^2$
- $1\text{ kWp} \times 4\text{hours/day} \cong 4\text{ kWh/day}$



Solar Applications



- ◆ Solar Thermal
 - Water Heating
 - Space Heating
- ◆ Photovoltaics
 - Grid Tied
 - Stand-Alone
 - UPS



Residential Grid-Tied Communities



Small rooftop systems in a PV community



PV and Buildings



City of Lakeland



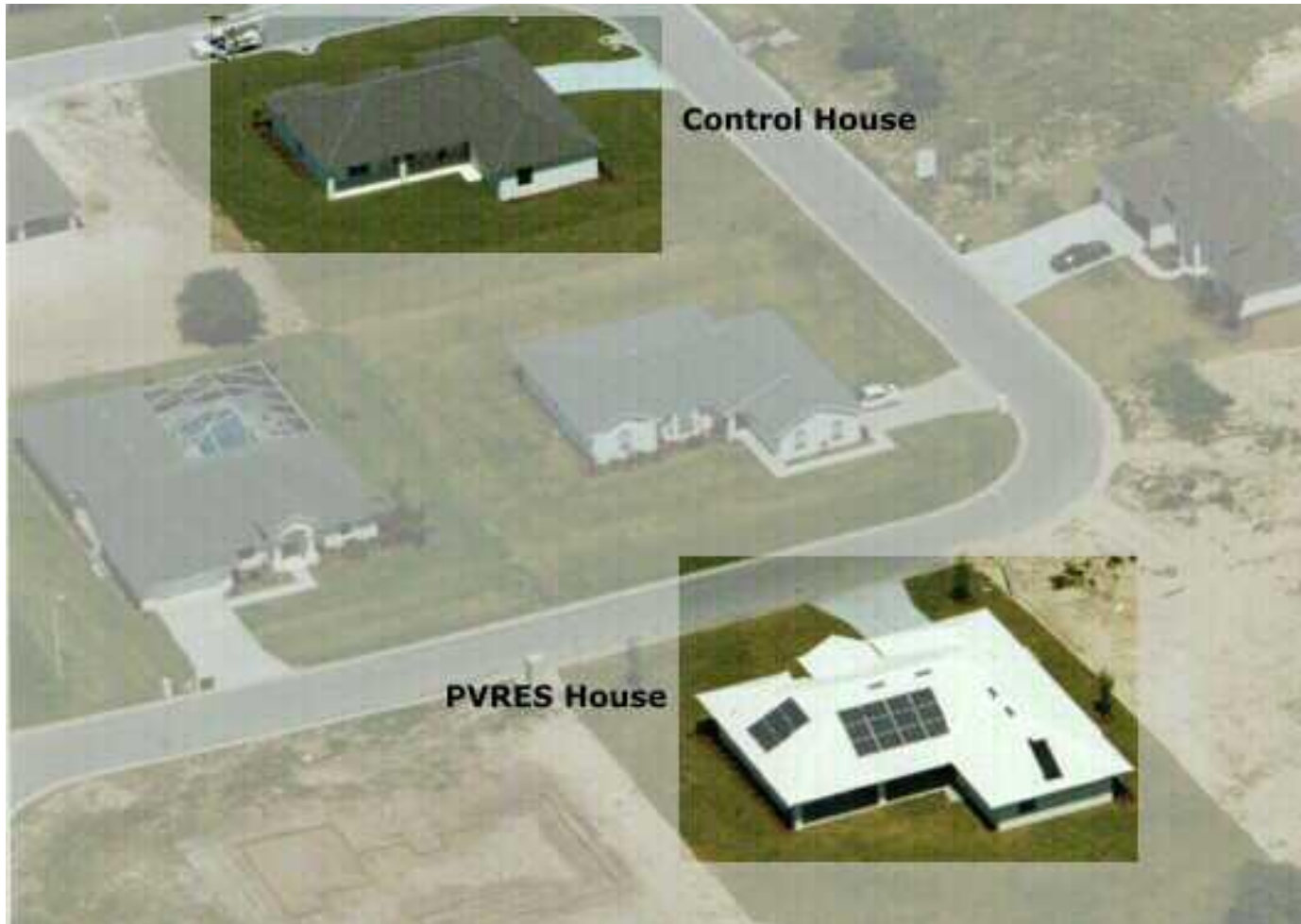
New Smyrna Beach, Florida



The Art of the Possible

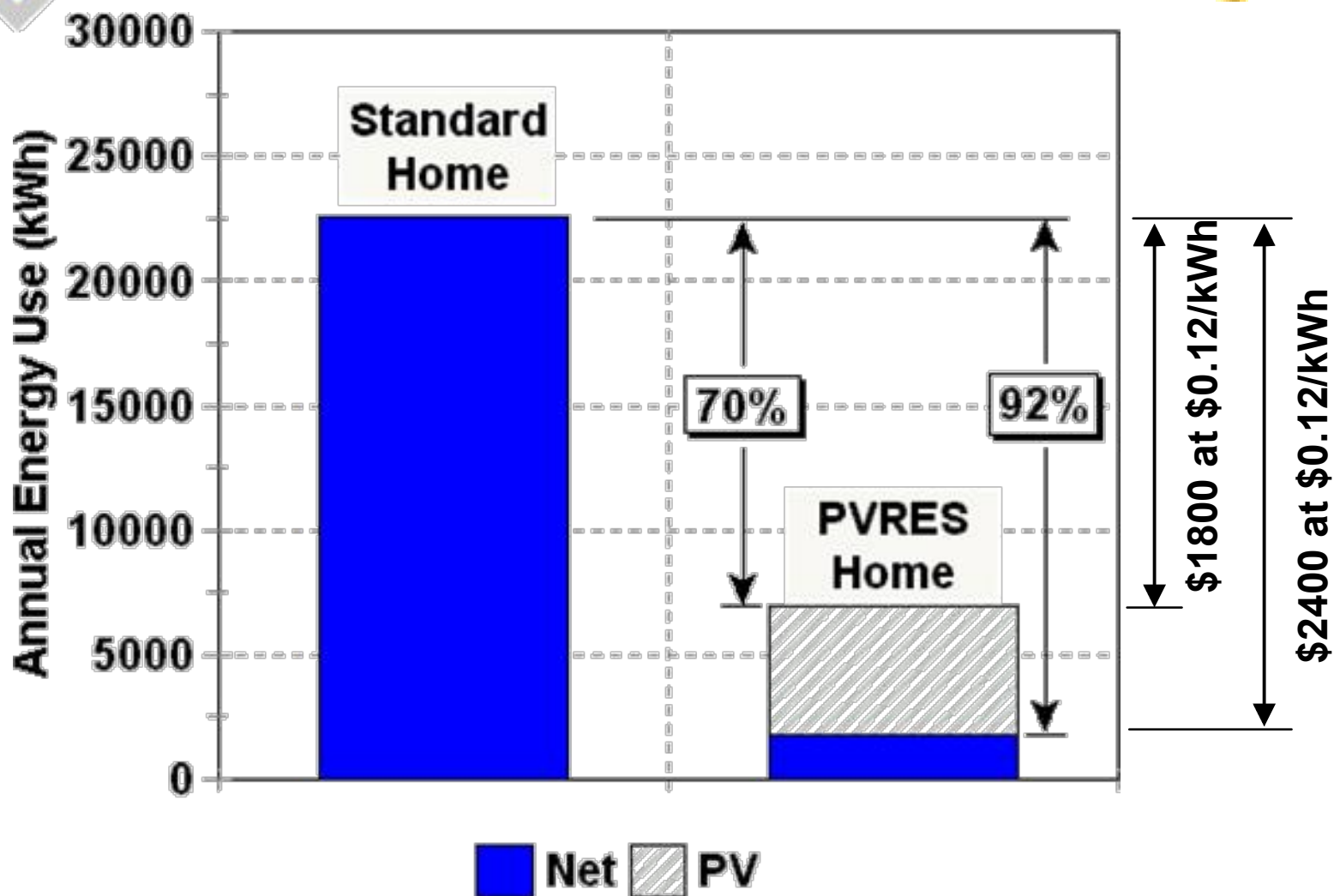


The First “Zero Energy Home”





Efficiency First

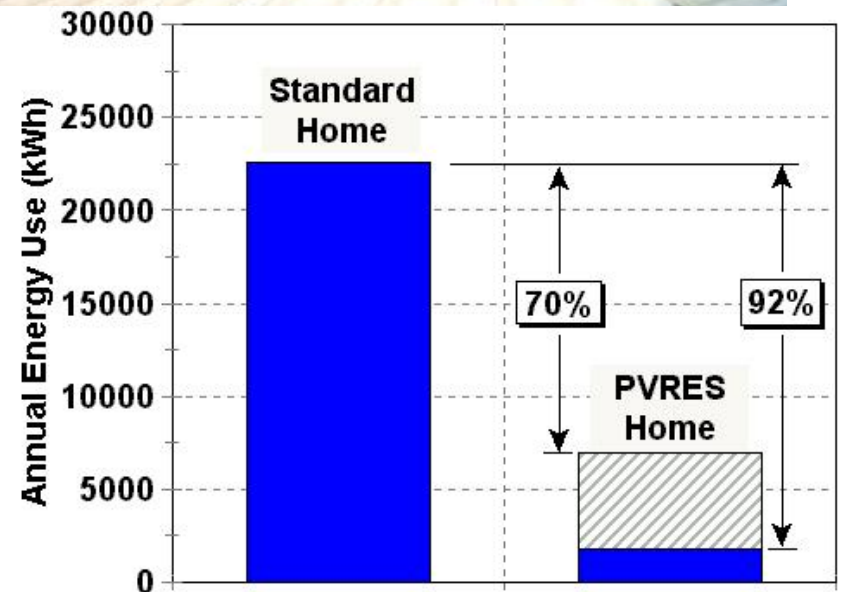




What about Economics?






- ◆ Our project:
 “Cost is no object”
- ◆ \$23,000 more to build
 - 12 % increase to cost (1998)
- ◆ PV system cost \$40,000
- ◆ Building efficiency measures will save $\approx 8,000$ kwh/year
 - \$960 annual savings at \$0.12/kWh
- ◆ PV system will produce $\approx 5,500$ kWh/year
 - worth \approx \$660 at \$0.12 kWh



Map of the United States showing the number of gun deaths per 100,000 people by state. States are colored red for high rates (above 25) and blue for low rates (below 25). Asterisks indicate significant gun culture. Hatched areas represent states with no data.

Legend (Gun deaths per 100,000 people):

- NH: 25
- MA: 60
- RI: 25 *
- CT: 100
- NJ: 2,000
- DE: 25
- MD: 500
- VA: 10 / 500
- DC: 100

-  **State-wide net metering for all utility types**
-  **State-wide net metering for certain utility types (e.g., IOUs only)**
-  **Net metering offered by one or more individual utilities**

#s indicate system size limit (kW); in some cases limits are different for residential and commercial as shown

Net metering is available in 40 states + D.C.



Net Metering



- ◆ State level electricity policy for small energy generation sources
- ◆ System owner receives credit for the unused portion of the electricity generated
- ◆ The monetary value of the retail credits can vary from the customer's rate.
- ◆ Credits may be banked for a limited period



Utility-Interactive PV System



PV Array



**Inverter/Power
Conditioner**



AC Loads



**Distribution
Panel**

Net Metering

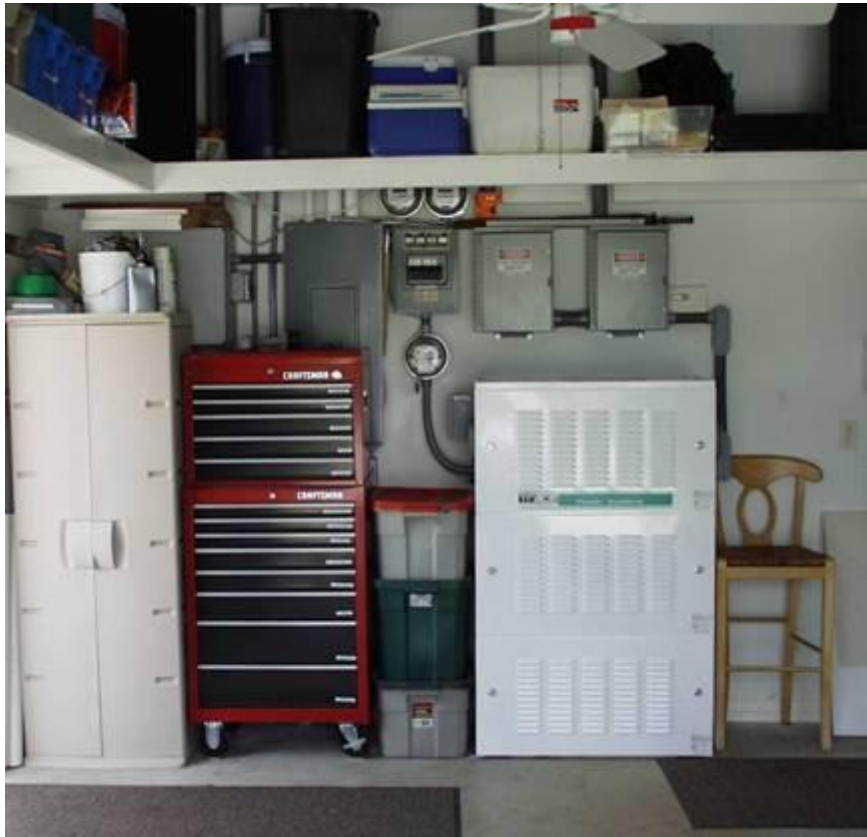


**Electric
Utility**



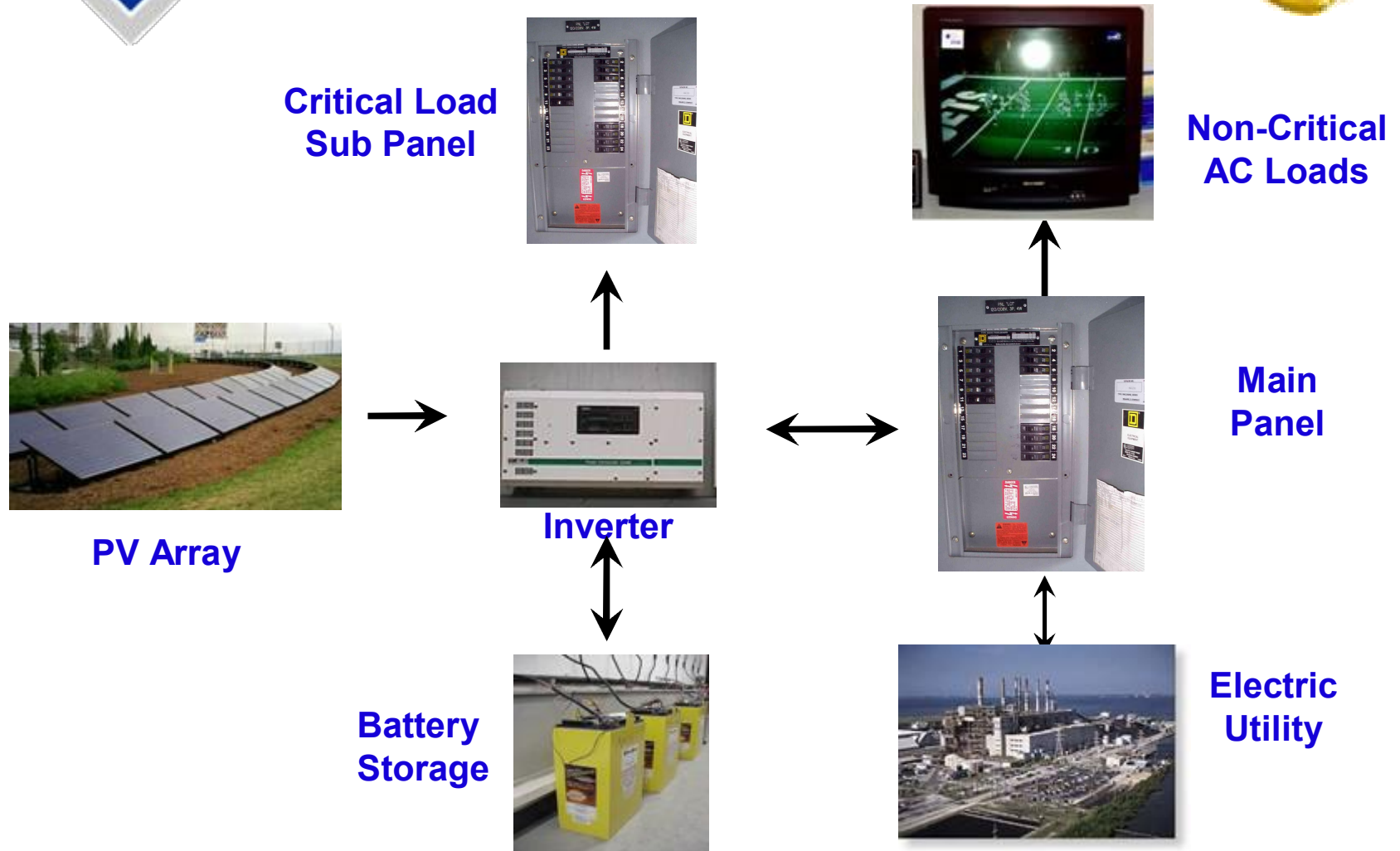


PV System with UPS Option





Grid-Tied System with Critical Load Backup (UPS)

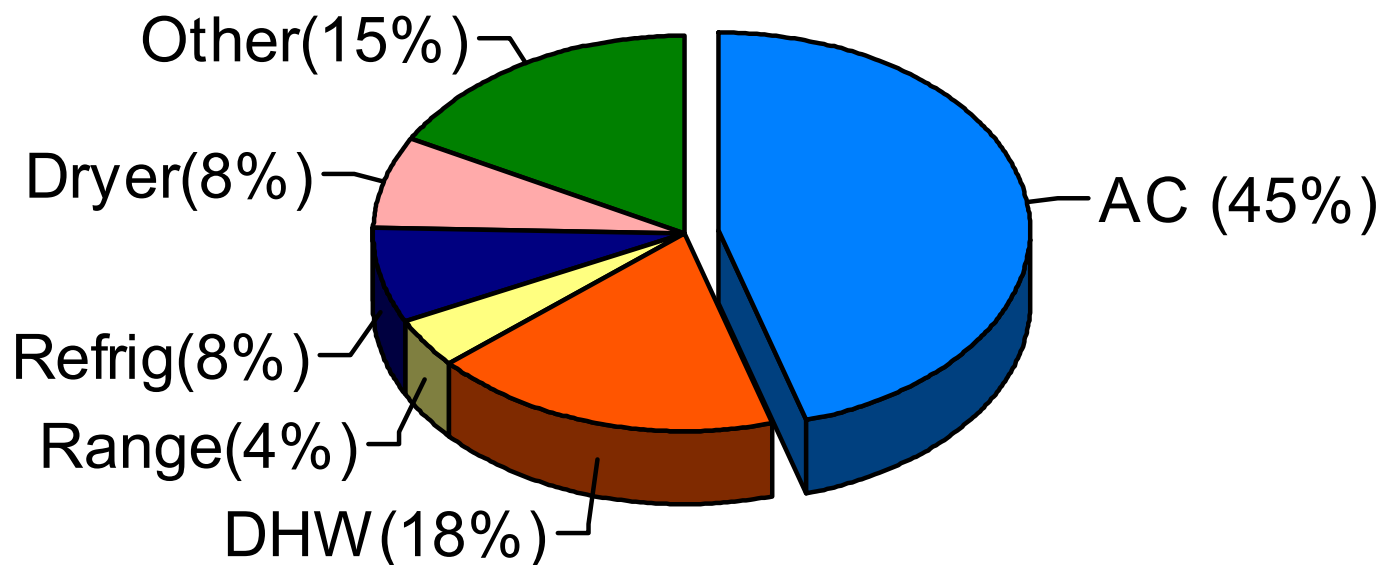




Where do we use energy?

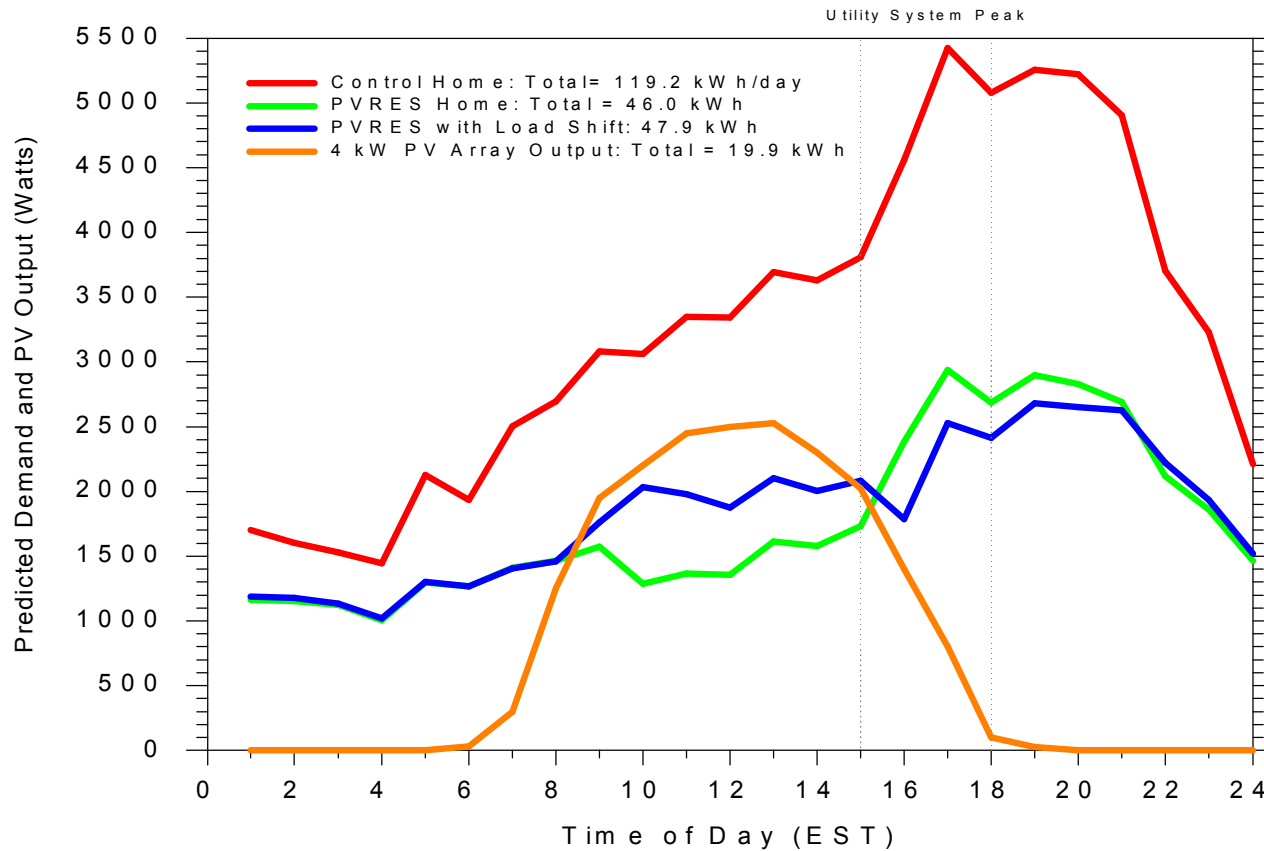


Avg Daily Consumption = 35 kWh





Matching PV Output to Loads



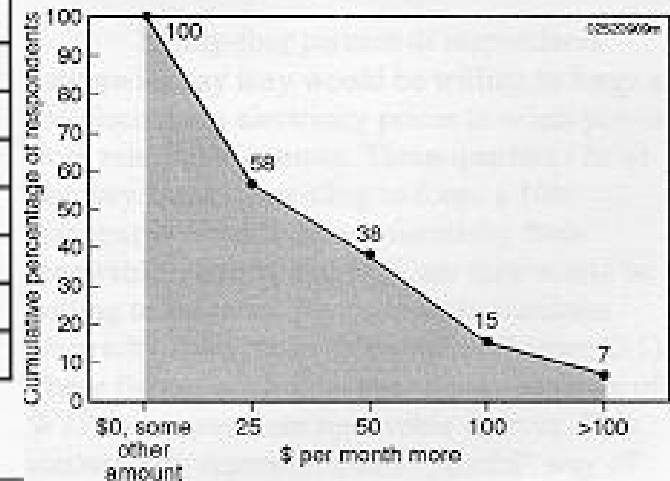


Customer Attitudes



Table A-1. Preferences among Energy Resources

Energy Resource	Somewhat or strongly favor %	Somewhat or strongly oppose %	Don't know %	Totals
Solar	93	5	2	100
Wind	91	9	—	100
Natural gas	83	11	6	100
Geothermal	71	13	16	100
Landfill gas	64	18	18	100
Forest waste	59	29	12	100
Nuclear	31	63	6	100
Coal	24	69	7	100



\$0 = 35%; Some other amount = 7%

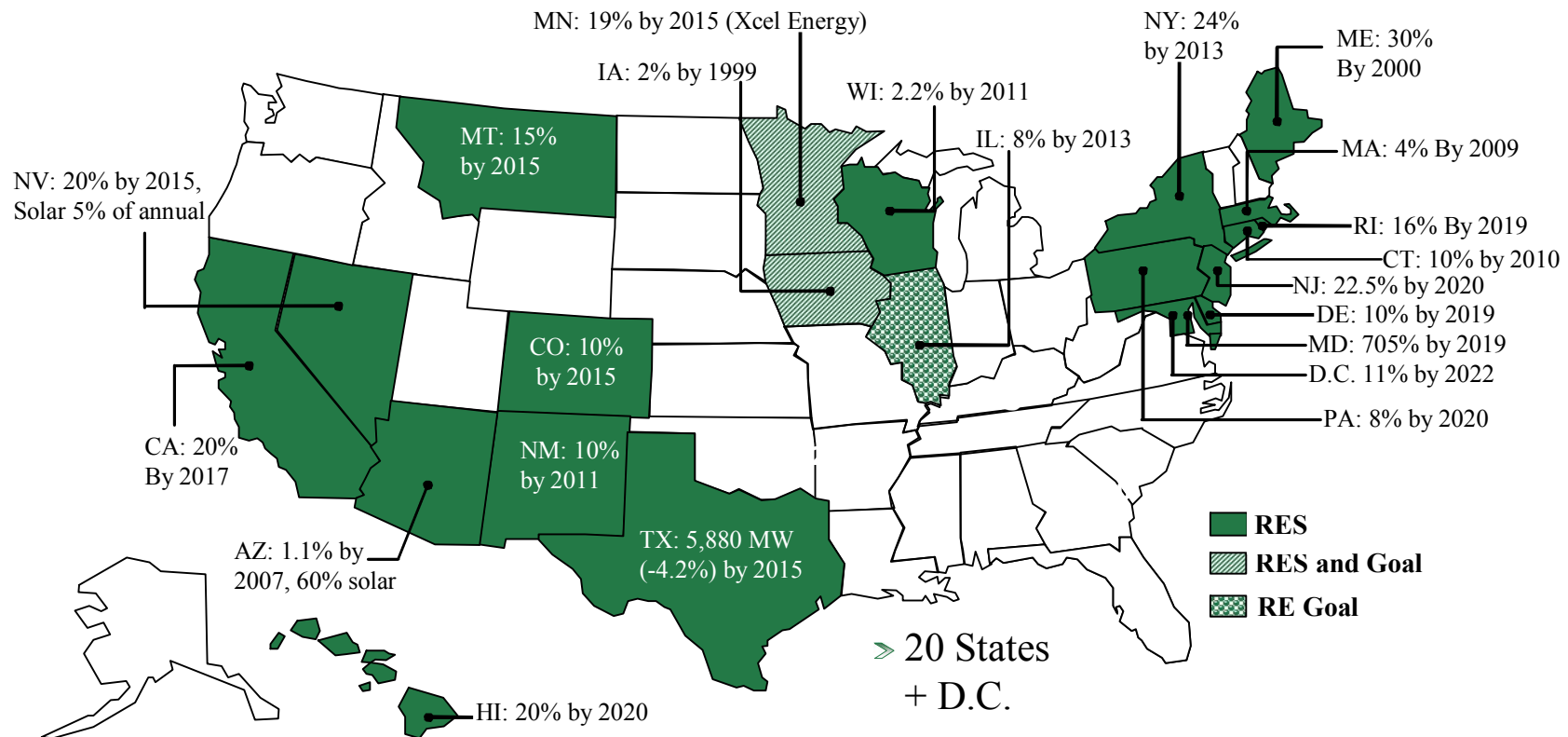
Figure B-10. Incremental Monthly Amounts Respondents Are Voluntarily Willing to Pay for Home-Based Rooftop PV System

• Willingness to Pay for Renewable Energy

- ◆ Consumers favor renewables
- ◆ Willingness to pay has limits



Renewable Electricity Standards

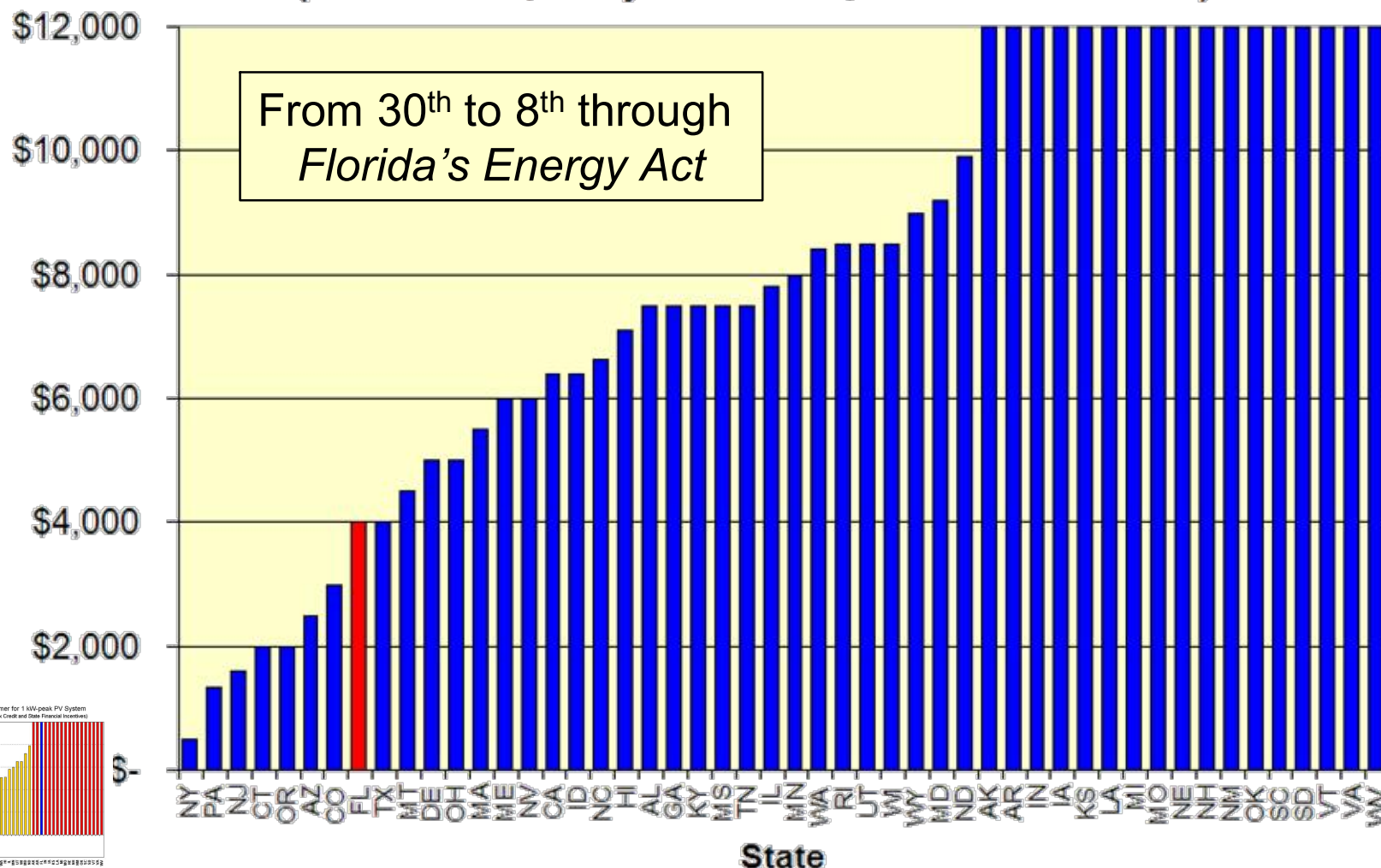




PV Rebates

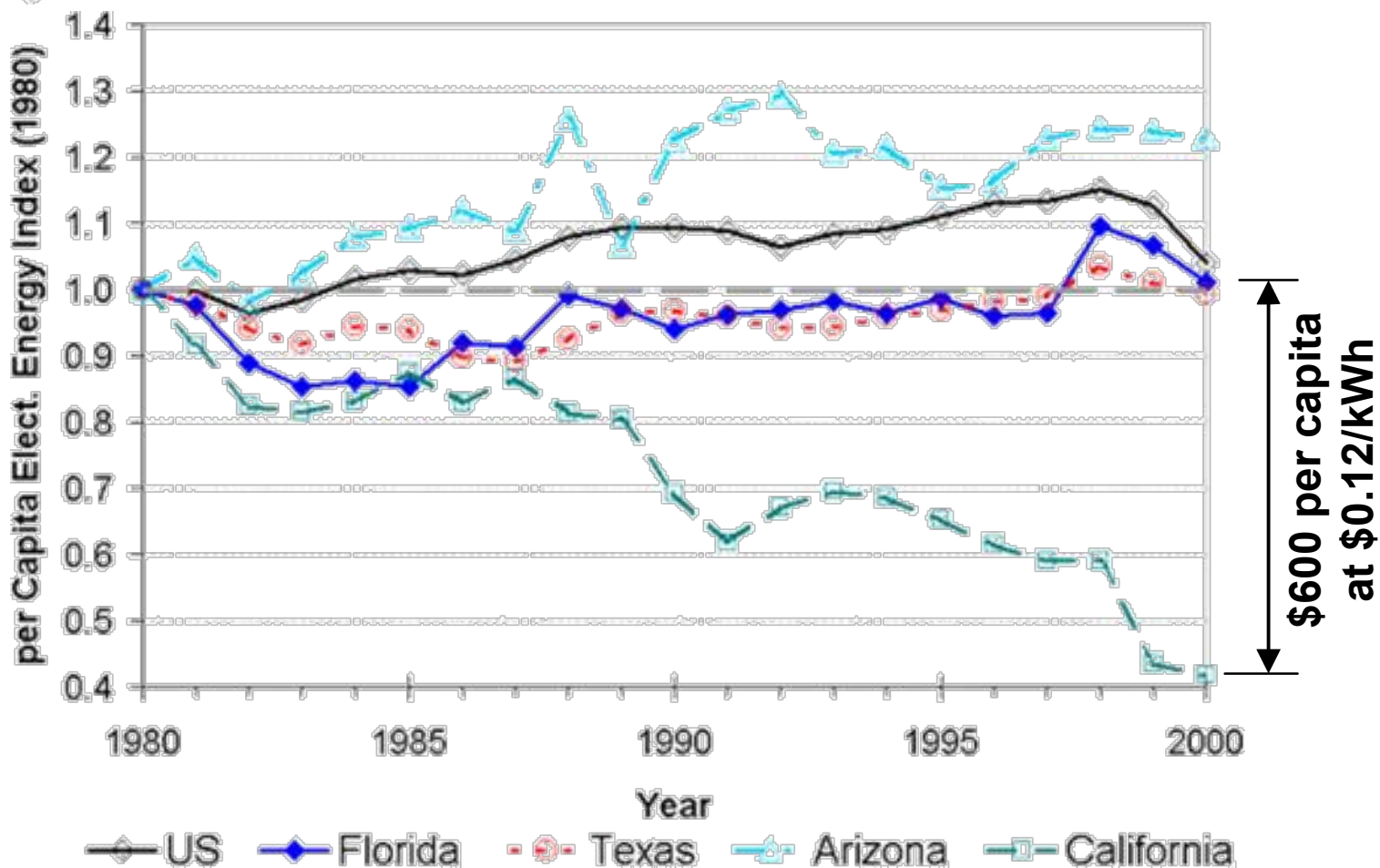


Final Cost to Consumer for a 2 Kilowatt PV System
(assumes \$16,000 system with \$2,000 federal tax credit)



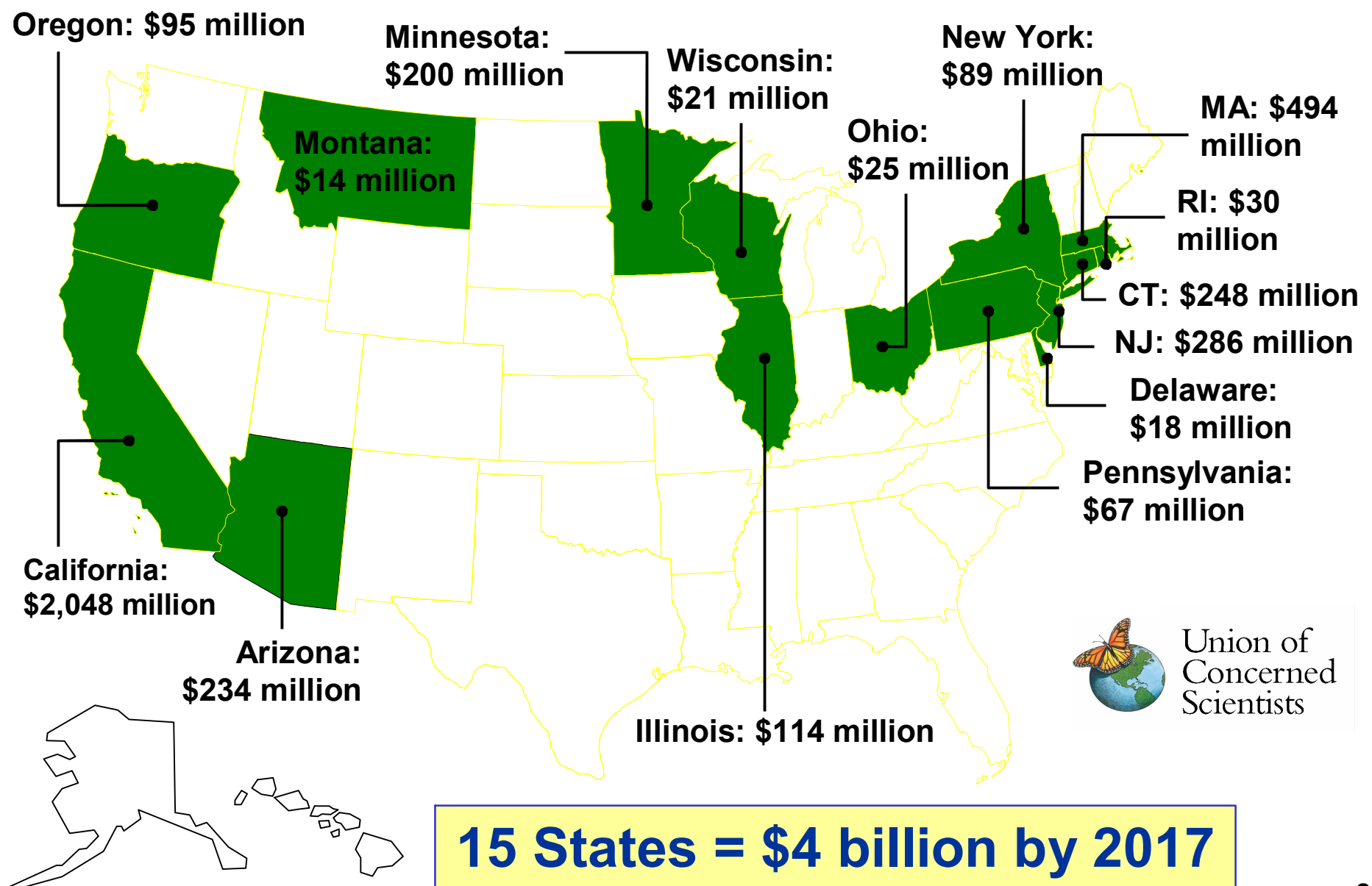


Per Capita Electrical Use (Indexed to the 1980 Value)



Data Source: U.S. DOE Energy Information Administration, 2004

Non-Appropriated Public Benefits Funds

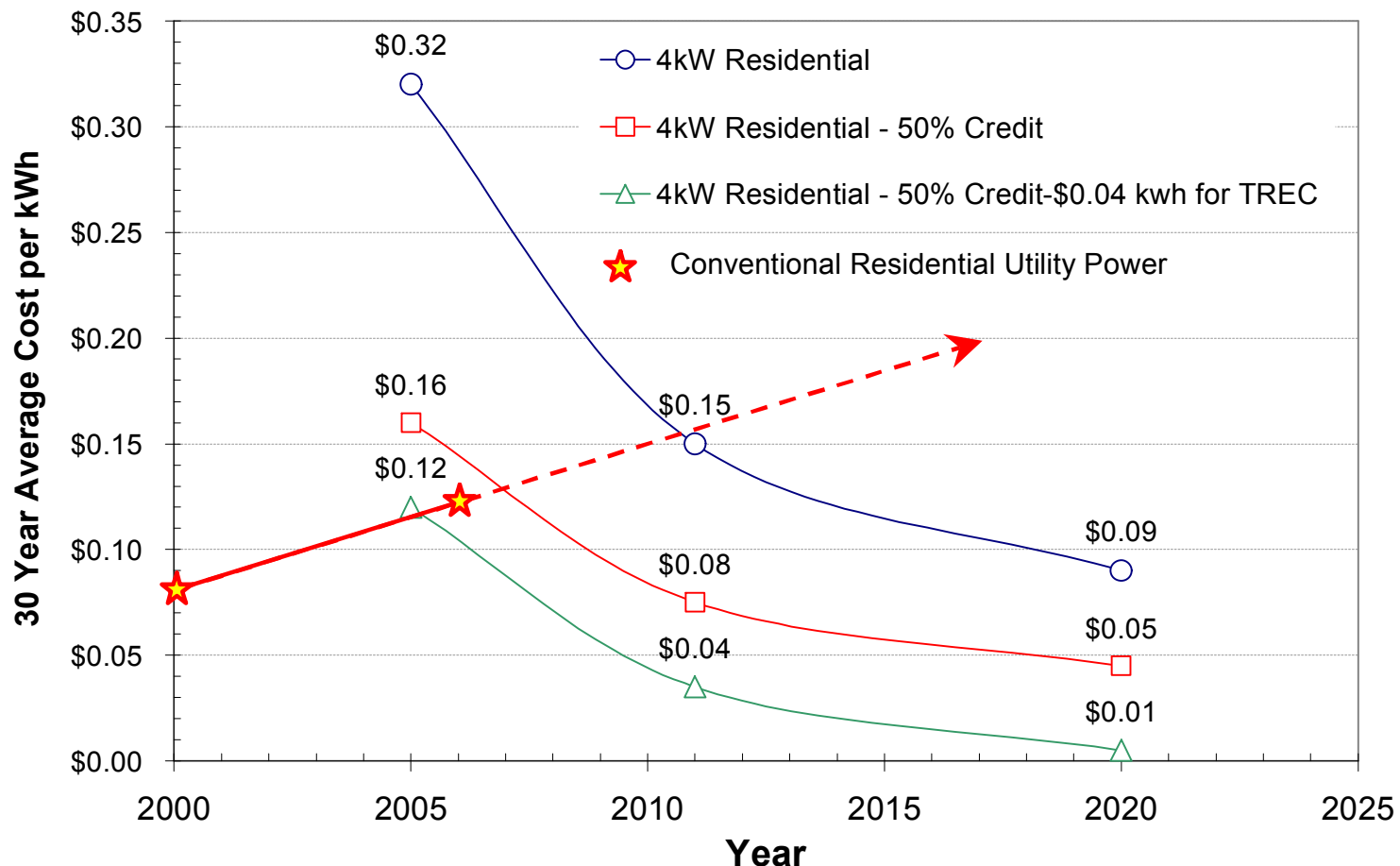




PV on Florida Rooftops



Actual and Future DOE Target Costs for PV*



<http://www.fsec.ucf.edu/echronicle/archives/2006/Q2/sunshine.htm>



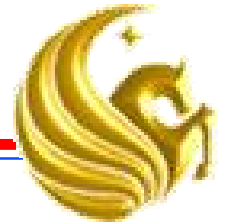
PV Cost



PV Module	\$4.31/watt
Other Hardware	\$1.65
Labor	\$2.04
Total	\$8.00/watt



PV Life Cycle Cost



\$ /kWp	\$ /kWh
\$ 8000	\$ 0.28
\$ 6000	\$ 0.21
\$ 4000	\$ 0.15



The End